

Alkanes

3 - Properties and Applications

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Properties of Alkanes

Here we will cover:

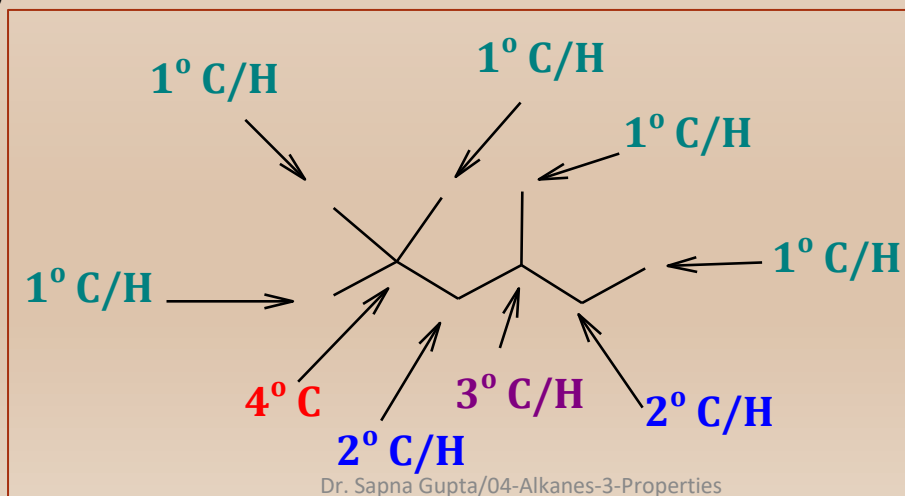
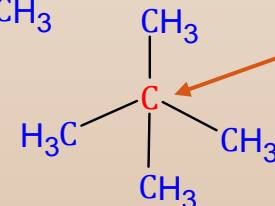
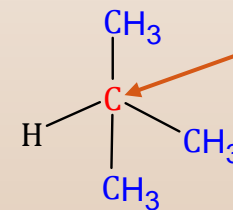
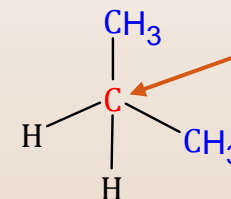
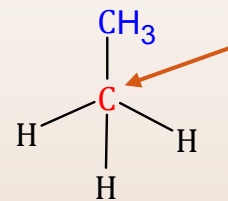
- Different types of carbon and hydrogens in an alkane/cycloalkane.
- Physical properties of alkanes.
- Where alkanes are found.
- Applications of alkanes.

Different types of carbon and hydrogens in an alkane/cycloalkane.

Carbons in an alkane are classified by how many carbons one carbon is connected to. Hydrogens are classified by how many carbons that one carbon that is connected to hydrogen is connected to. The classification helps to understand the properties of that carbon/hydrogen. Other functional groups, as we learn them, can also be classified in a similar manner.

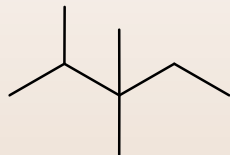
Classification of Carbons and Hydrogens

- Primary (1°) C: A **carbon** bonded to one other carbon.
 - 1° H: a hydrogen bonded to a 1° carbon
- Secondary (2°) C: A **carbon** bonded to two other carbons.
 - 2° H: a hydrogen bonded to a 2° carbon
- Tertiary (3°) C: A **carbon** bonded to three other carbons.
 - 3° H: a hydrogen bonded to a 3° carbon
- Quaternary (4°) C: A **carbon** bonded to four other carbons.



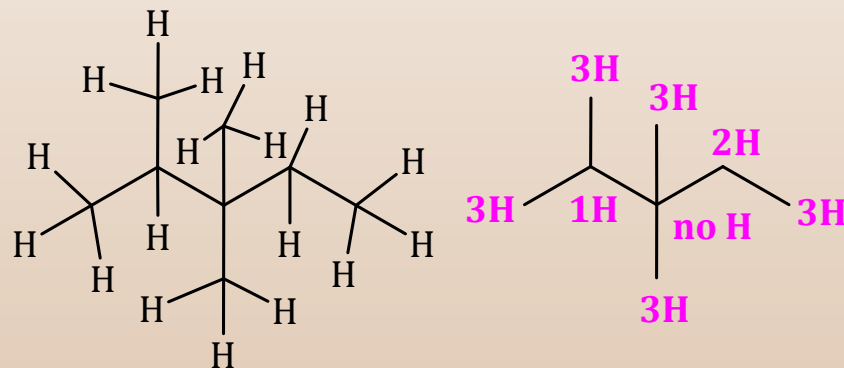
Solved Problem: Number and types of carbons

Give the number of hydrogens on each carbon on the structure given below. Classify all the carbons and hydrogens as primary, secondary, tertiary and quaternary.

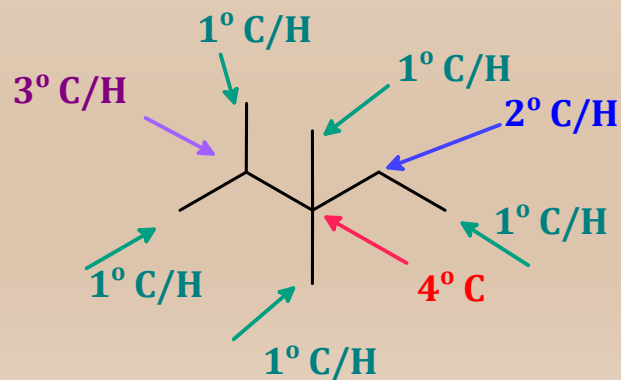


ANSWER

Number of hydrogens: Draw the expanded structure first to see all the hydrogens and then count them. Note that all the terminal carbons have 3 hydrogens, so no need to count if you don't want to. For a quick count, see how many bonds are coming out of that carbon, the rest are H.


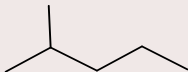

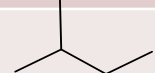



Classification of carbons and hydrogens: For classifying carbons, see how many Hs are attached to it OR quicker way is how many C are attached to it – 1 C means primary, 2 carbons means secondary. Primary carbons have primary hydrogens and secondary carbons have secondary hydrogens etc.



Physical Properties of Alkanes

- 1) **Boiling points and melting points** increase as size of alkane increases since dispersion forces increase as electron density increases.
- Straight chain compounds have a higher boiling point than branched alkanes.
 - Cycloalkanes have similar properties to straight chain alkanes.
 - Constitutional isomers have different physical properties (melting point, boiling point, densities etc.). See table below for example.

C_6H_{14}	Mpt $^{\circ}C$	Bpt $^{\circ}C$	Density g/mL
	-95	68.7	0.649
	-153	60.3	0.653
	-118	63.3	0.664
	-129	58	0.662
	198	49.7	0.649

Physical Properties of Alkanes, contd...

- 2) Solubility in Water** – Alkanes are not soluble in water as they have dispersion IMF and water has H-bonding.
- 3) Density** (compared to water) – Alkanes are less dense than water. When an alkane is added to water, it will be the top layer.
- 4) Odor** – Most alkanes are pleasant smelling.

Alkane Sources

Most usable alkanes are obtained from under the earth through drilling.

- Natural gas, methane, is obtained through fracking.
 - Petrol can be obtained from under the earth on land or water (offshore drilling)
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- ❖ All extractions are generally polluting and dangerous.
 - ❖ But alkane extraction produces not only alkanes but other ancillary aromatic products.
 - ❖ Cracking is a way to make unusable alkanes into usable products.
 - ❖ Other sources of methane are gases from volcanoes and cattle.

Applications

- Fuel source – Most alkanes are good for energy production – natural gas (methane), compressed gas (propane), lighter fluid (butane) petrol (isooctane), kerosene (C_{10} - C_{16} alkanes) etc.
- Solvents – Alkanes such as hexane are used in labs and industry as nonpolar solvents.
- Miscellaneous – A number of our daily use items are alkanes, e.g. wax (candles), Vaseline.

Key Words/Concepts

- Be able to compare physical properties of alkanes to each other and other functional groups as we learn them.